

National Aeronautics and
Space Administration



ASTROPHYSICS



Astrophysics Technology

COPAG – 235th AAS

Mario R. Perez

Astrophysics Chief Technologist

January 4, 2020

NASA Headquarters



Outline

- Astrophysics Technology Portfolio and Elements
- Technology Lessons Identified from the last 10 years
- Upcoming Technology Opportunities
- Emergent Technologies

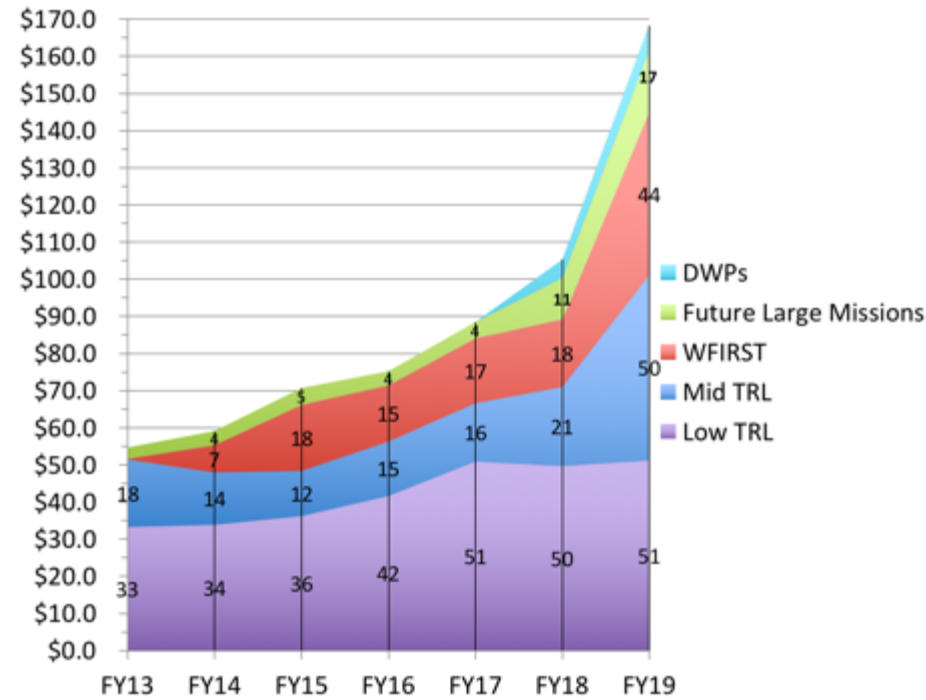
Astrophysics Technology Portfolio

Center's Chief Technologists

PCOS/COR PO Technologists

SMD Chief Technologist

XEP PO Technologists



APRA Technology
\$50M/y

RTF
\$1M/y

SAT
\$25 M/y

NEID Construction
\$4.8 M/y FY19

Subject Matter Experts

MSFC Procurement

WFIRST Technology
\$43.7 M/y

L & M Mission Concepts
\$10M/y in FY19

Lisa/Athena
\$35M/y

ISFM
\$3M/y

de
y

SmallSats
\$1M/y

CubeSats
\$5+M/y

Astrophysics Technology Program Elements

Technology Inception & Experimentation APRA/RTF

- 46 projects awarded in 2019
- Solicitations planned in FY20, delayed 9 months
- Average award: \$600K (3-5 years)
- Average selection rate: 28%
- Portfolio:
 - Supporting 19 Balloons and 10 Sounding Rockets Payloads
 - Detectors across wavelengths
 - Mirrors, coatings and gratings

Total: \$50 M per year

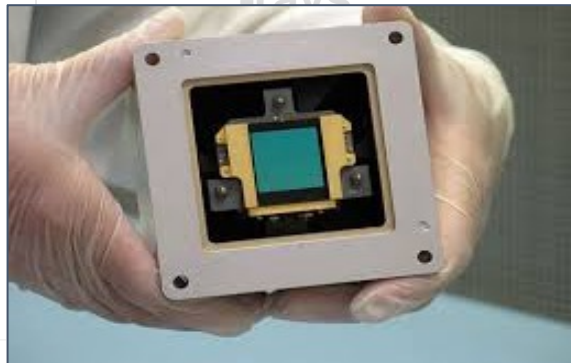


Technology Maturation SAT & ISFM

Unified solicitation and selection starting in FY19 for the three Astrophysics themes. Portfolio has 49 active projects.

- 12 new projects awarded in FY19
- Next solicitation planned in FY20, currently TBD
- Average award: \$1.6M (3 years)
- Average selection rate: 30% (in FY19, historically is 29%)

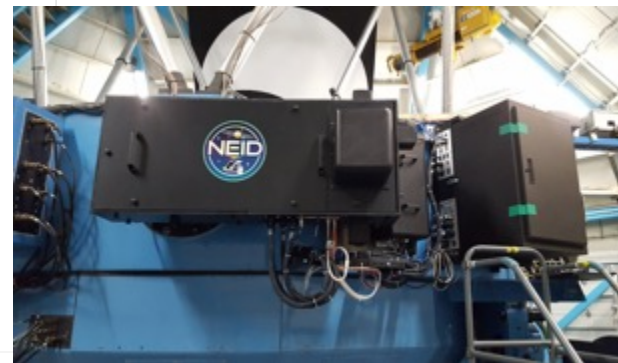
Total: \$28 M year



Directed Technologies

- WFIRST Coronagraph
- Exoplanets Probes: Exo-C & Exo-S
- LISA
- Athena
- Euclid
- NN-Explore – NEID
- SmallSats and CubeSats

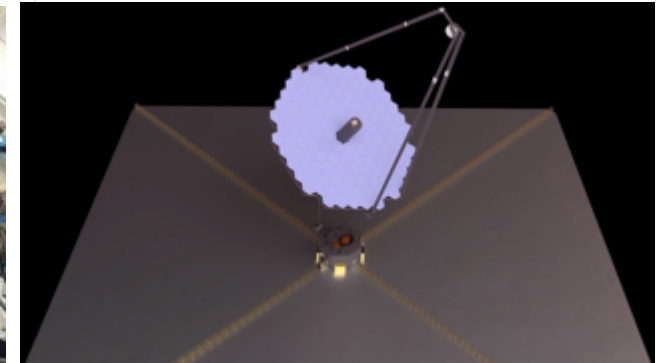
Total: \$85 M in FY19

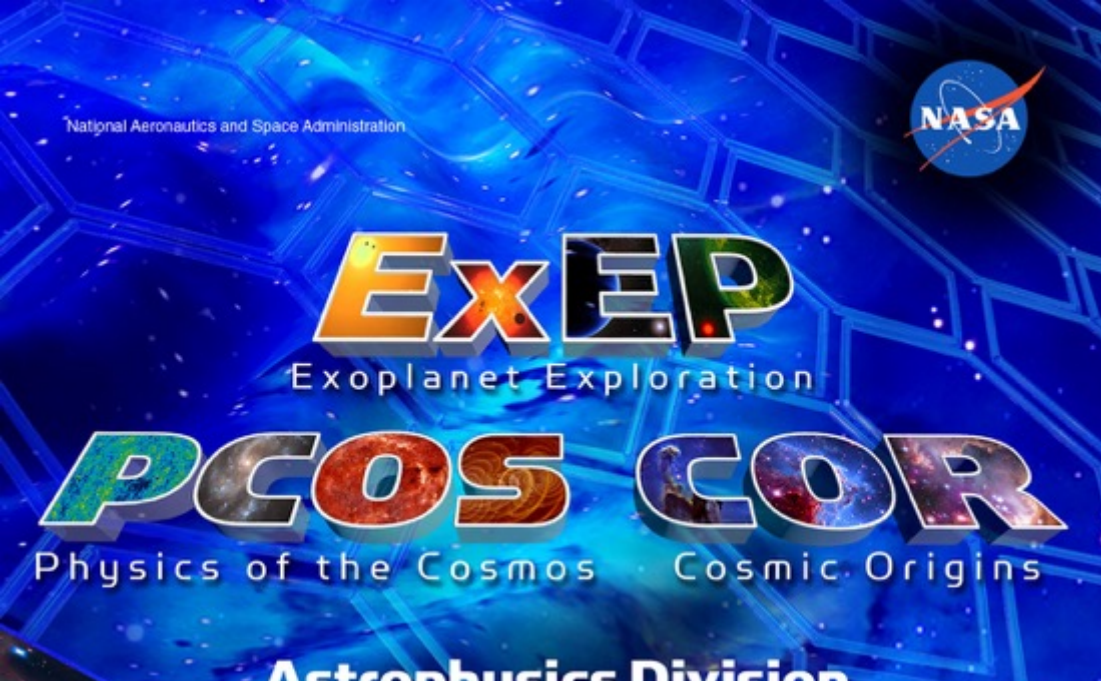


Pre-Decadal Initiatives

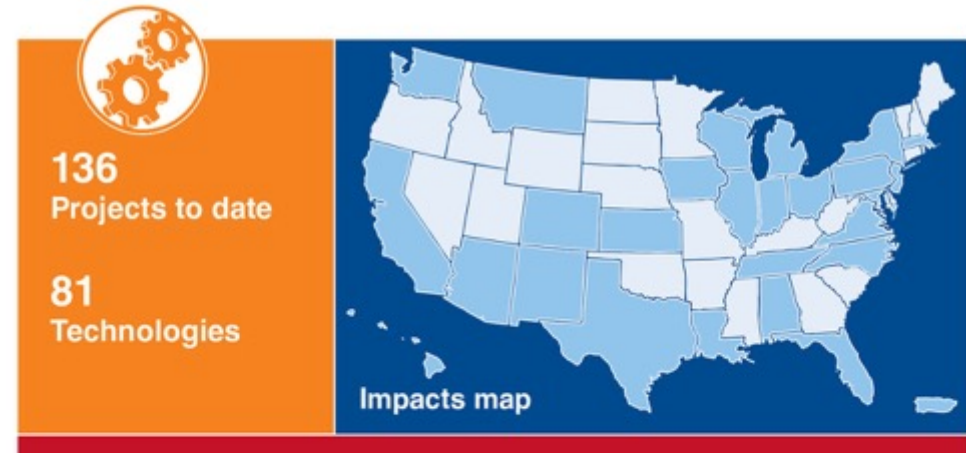
- In-Space Assembled Telescope (iSAT)
- Coronagraph and UltraStable Testbeds
- Starshade Technology
- Four Large Mission Concepts – Technology Roadmaps
- Ten Probe Mission Concepts
- Segmented Mirror Telescope Program (STMP)

Total: \$25 M in FY19



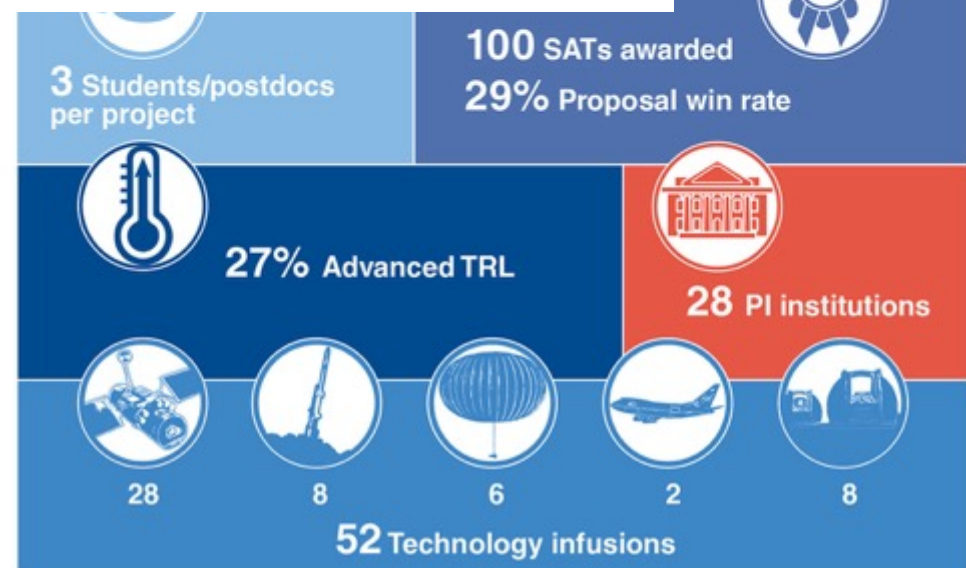


APD Published First Integrated Strategic Technology Portfolio



<http://www.astrostrategictech.us>

**Astrophysics
Biennial
Technology
Report
2019**



Segmented Mirror Technology Program Phase 1 (SMTP1) Document Archive

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NASA ROSES-19 Amendment 2: New program element: D.13 System-Level Segmented Telescope Design – Technology Maturation

Status Report From: [NASA Science Mission Directorate](#)

Posted: Thursday, April 4, 2019

ROSES-19 Amendment 2: This amendment introduces a new program element as [D13. System-Level Segmented Telescope Design – Technology Maturation](#)

This new program element solicits industry proposals to carry out a two-year technology maturation development effort and associated testbed demonstrations to advance technologies that enable large segmented-aperture (10-meter-class or larger) or large monolithic (4-m or larger) telescopes. These architectures will include integrated coronagraphs that advance the design maturity (e.g., Technology Readiness Level, TRL, of components and system), and identify future technology investments. These advancements will enable implementation of the next generation of large space telescopes.

Only for-profit U.S. industrial organizations are eligible to submit proposals to this program element. There are no restrictions on the types of organizations that participate as subawardees. It is anticipated that awards resulting from successful proposals to this program element will be Firm-Fixed-Price contracts. The total budget available for awards resulting from this program element is approximately \$8.4M for two years, which we estimate may support up to three successful proposals. The government reserves the right to not select any responses to this program element.

Final reports of Phase 1, submitted by the two selected teams and they are available at the Technology Archive Website:

<http://www.AstroStrategicTech.us>

Roman Technology Fellowship Program



Dr. Nancy Grace Roman
1925-2018

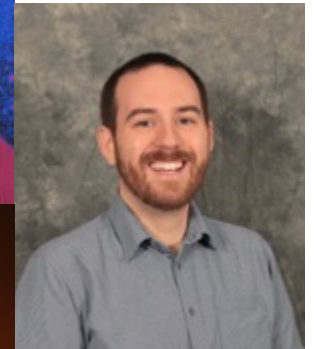
NASA PECASE - 2019



RTF fellows at the RTF Special Session held at the AAS meeting in June 2018: From the left: Erika Hamden (Caltech/U. Arizona), Cullen Blake (U. Pennsylvania), Brian Fleming (U. Colorado), and Abigail Vieregge (U. Chicago).

Roman Technology Fellowship Program

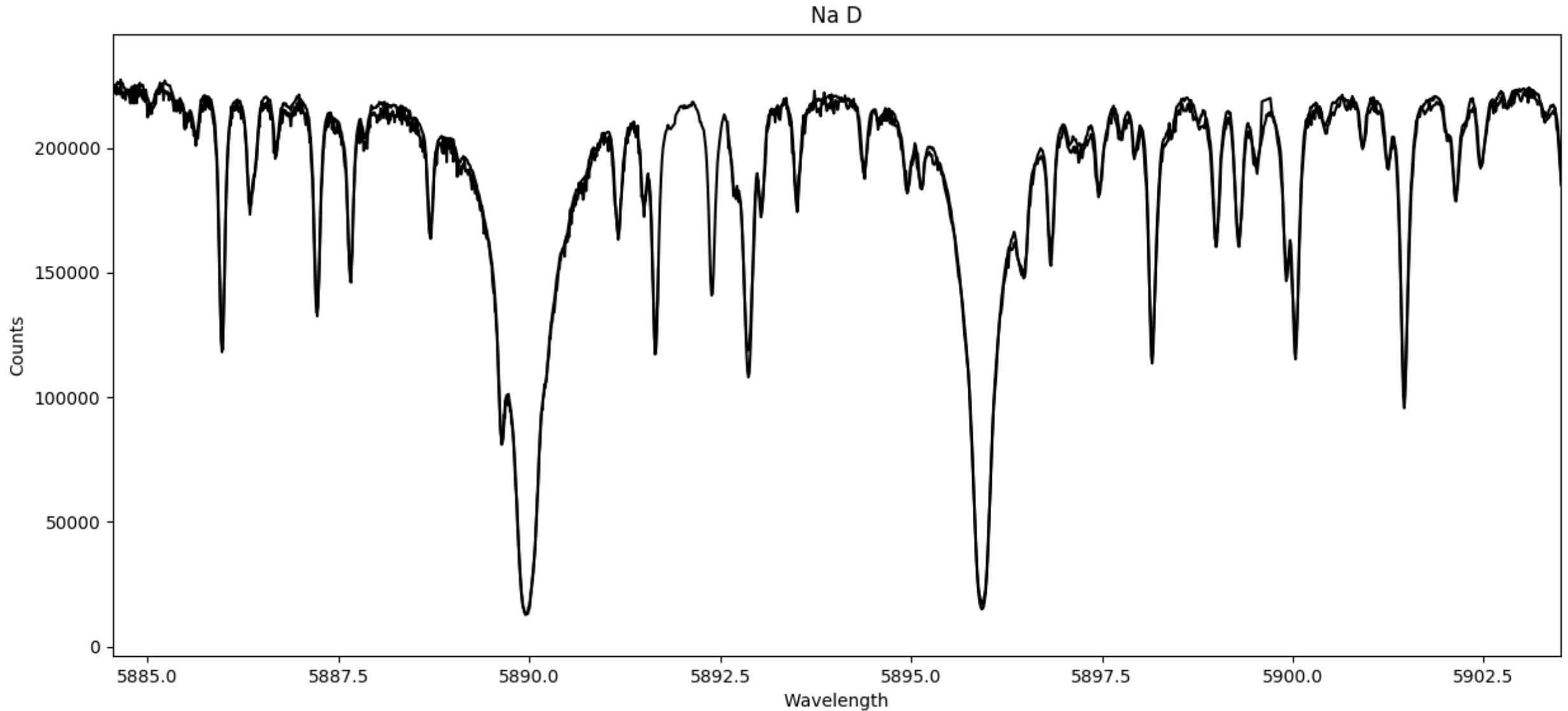
- 19 current and recent fellows (15 male, 4 female)
- Typically in academia and National Laboratories (including NASA Centers)
- Budget stable at about \$1.3 M per year
- \$300 K in startup funds for each fellow, over 3 years
- APD organized a special session at the last SPIE conference (August 2019) to showcase and celebrate the work of the RTF fellows
- 2019 selections made in November 2019 (ROSES-2018):
 - *Regina M. Caputo (Ph.D. 2011), NASA-GSFC, Gamma-ray and Cosmic-ray astrophysics*
 - *Gregory N. Mace (Ph.D. 2014), UT Austin, Advanced Optics and Spectroscopy Applications*
 - *Sarah N. Heine (Ph.D. 2014), MIT, Bragg Reflector Optics and Gratings for Polarimetry*



NEID Extreme Precision RV Spectrograph at WIYN

Telescope (KPO) – October 2019

First Light in December, 2019



The unique role of technology in space-based observational astrophysics: Lessons from the last 10 years

FACTS

- Astrophysics is a photon discipline, demanding exquisite performance from instruments and subsystems utilized in on-sky observation and detection.
- NASA Astrophysics seeks to answer the most difficult and profound questions about the formation and origin of the Universe and is searching for life outside our Solar System.
- None of the obstacles to the next level of detection in observational astrophysics are physical in nature; they are technological in nature.
- The astrophysical problems NASA demand all available resources, including archives, ground- and space-based.
- Management of technology is critical to guarantee success.

Physics

Mission

Gaps

Resources

Process

Why Astrophysics?

Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.

★ How did our universe begin and evolve?

☄ How did galaxies, stars, and planets come to be?

● Are we alone?

Enduring National Strategic Drivers



Upcoming Technology Opportunities

- **Space Technology Mission Directorate (STMD)**
 - **Space Technology Research Grants (Annual Calls)**
 - Space Tech Graduate Research
 - Early Career Faculty (ECF)
 - Early Stage Innovation (ESI) – Three topics from Astrophysics – check: <https://www.nasa.gov/directorates/spacetech/strg/early-stage-innovations-esi>
 - Space Technology Research Institutes (STRI)
- **Science Mission Directorate (SMD)**
 - **Entrepreneur Call** – New fast turn-around solicitation: Include topics that respond to a science need and that have commercial potential; Astrophysics is contributing topics – Event: TBD (spring) at NAS in Washington DC
- **Astrophysics Division – ROSES - 2020**
 - **APRA & RTF** – NOIs due on October 23, 2020 and Proposals are due on December 17, 2020
 - **SAT** – TBD (considering options)

Emergent Technologies

(as applied to Astrophysics technology needs)



Integrated Photonics



Small Satellite Technologies



Intelligent Autonomous Systems (AI)

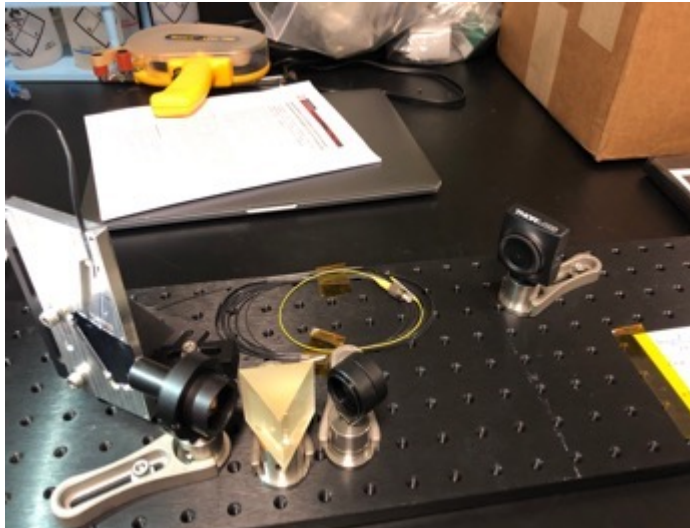


Quantum Sensing, Imaging and Algorithms



Novel Materials (metals, polymers, ceramics, and composites)

Emergent Efforts



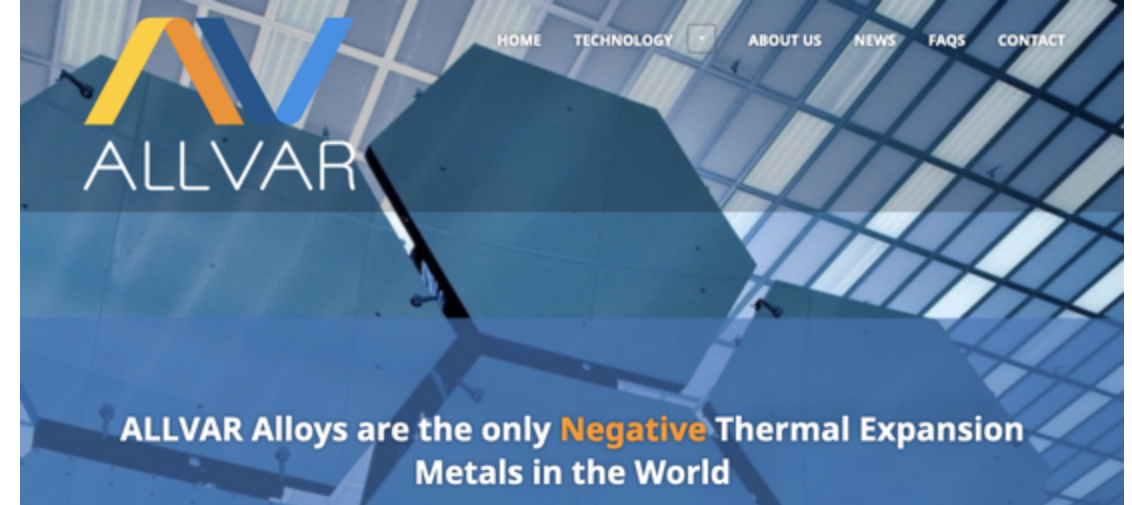
Research Article

Vol. 25, No. 15 | 24 Jul 2017 | OPTICS EXPRESS 17753

Optics EXPRESS

Demonstration of an efficient, photonic-based astronomical spectrograph on an 8-m telescope

N. JOVANOVIĆ,^{1,2,*} N. CVETOJEVIĆ,³ B. NORRIS,⁴ C. BETTERS,⁴
C. SCHWAB,^{2,5} J. LOZI,¹ O. GUYON,^{1,6,7,8} S. GROSS,^{1,9}
F. MARTINACHE,¹⁰ P. TUTHILL,⁴ D. DOUGHTY,¹ Y. MINOWA,¹
N. TAKATO,¹ AND J. LAWRENCE^{2,5}



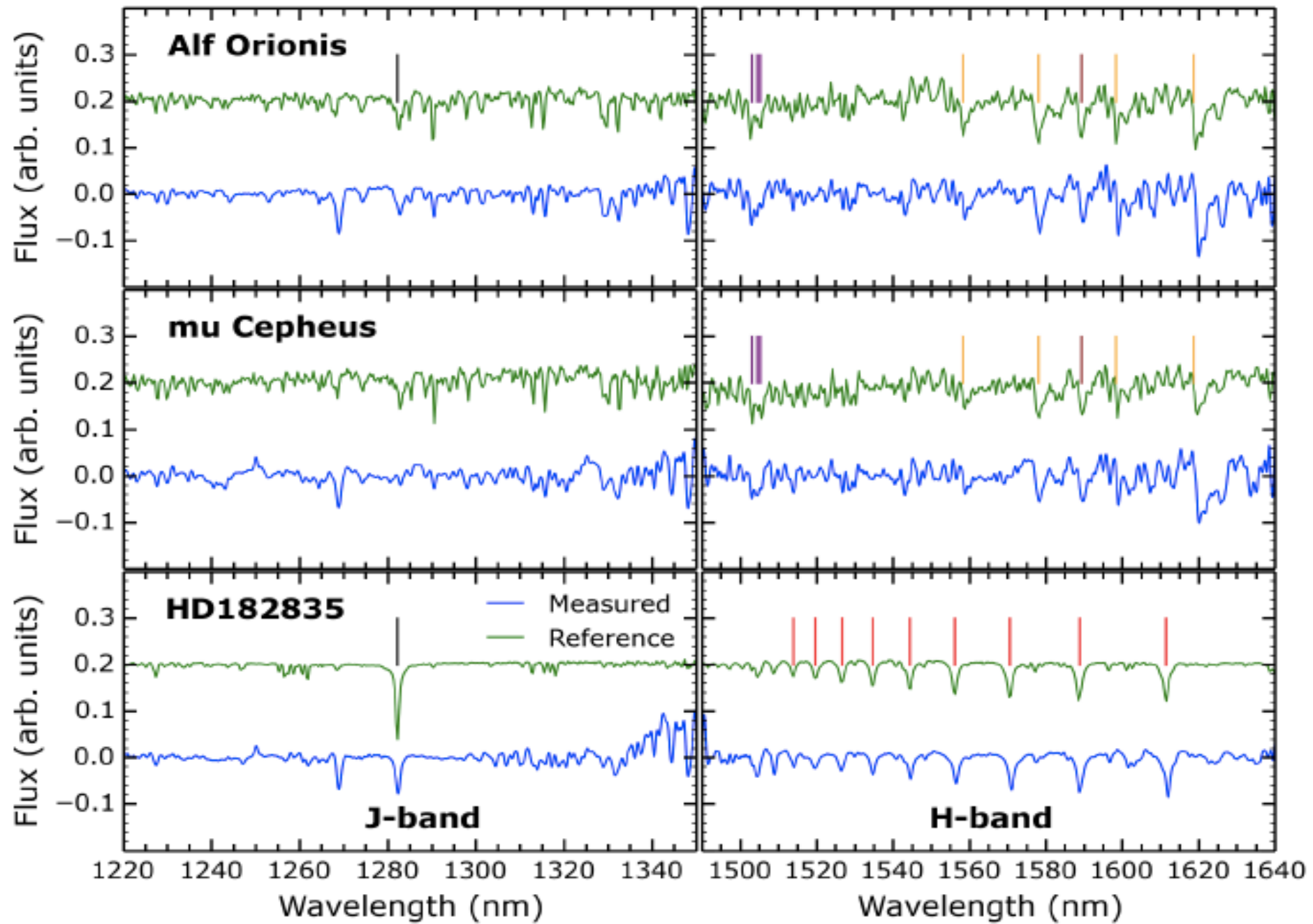
Astrophotonics: The Next Wave in Astronomical Instrumentation

Sylvain Veilleux

(U. Maryland, Joint Space-Science Institute)

Astrophotonics: Using photonics to improve and miniaturize astronomical instrumentation







National Aeronautics and
Space Administration



Workshop on Space Quantum Communications and Networks

Developing the Roadmap to Quantum Communications in Space

Hosted by the Space Sciences Laboratory
University of California – Berkeley
7 Gauss Way, Berkeley, CA 94720
Thursday, January 30 – Friday, January 31, 2020

Technology Interest Group (TIG) Charter

*Contact:
Sarah Tuttle at
tuttlese@uw.edu*

- The TIG is open to any interested member of the S&T community¹⁶; with members of both the astrophysics technology together with members of the relevant professional industries, as well as any additional people who can bring expertise or insight into the process.*
- One goal of the TIG is to provide an element of oversight and informed input concerning the state of the art for a variety of relevant technologies.*
- Through the TIG, the astrophysics community will update the existing community-assembled roadmap for technology development for missions. The TIG will facilitate communication that will merge the needs and desires of the science community with the achievements and plans of the broad technology community (e.g., defense, national security, remote sensing, photonics, etc.)*
- The TIG activities are year-around. The results of the TIG's work will be reported to the COPAG Executive Committee and the APAC.*

A composite image of space. The background is a deep blue field filled with numerous stars. A prominent, bright, and detailed view of the Milky Way galaxy stretches diagonally across the upper half of the frame. In the lower portion, the curved horizon of the Earth is visible, showing a thin blue atmospheric layer and a glimpse of the dark, cloud-covered surface. The text "Many Thanks" and "Questions?" is centered in the middle of the image in a yellow font.

Many Thanks

Questions?